Full liners for Medical
Consulting, machine, automation, programming, service and support for quality management and certification issues
Overview
Four segments
Dental
Additive manufacturing
Integrated digitization

We support you during all stages

DIGITIZATION & SERVICE
+ DMG MORI Connectivity in standard
+ DMG MORI NETservice
+ my DMG MORI Customer Portal for service optimization

DMQP & PARTNER
All topics related to the machine (e.g. tooling, clamping ...)

MACHINING & TURN KEY
+ Turning & milling
+ LASERTEC SLM
+ ULTRASONIC
+ Automation

EARLY INVOLVEMENT
DMG MORI MEDICAL EXCELLENCE CENTER
Consulting, process & technology development, ...
MARKET & PARTS
+ Implants
+ Prostheses
+ Instruments
+ Devices

REGULATION & CERTIFICATION
+ Consulting for market barriers, ISO 13485, FDA
+ Greenfield projects

COMPLETE PROCESS CHAIN
+ Machining method
+ Simulation
+ CAM (NX / ESPRIT)

MARKET GROWTH
+17% MARKET GROWTH

OF OUR CUSTOMERS

STANDARD PROCESS
Machine, time study, quote, order, delivery, ...
Overview
Four segments
Dental
Additive manufacturing
Integrated digitization

DMG MORI MEDICAL EXCELLENCE CENTER

Expertise in the medical sector – four segments

IMPLANTS
Filigree components and screws, joints and bone plates
More from page .........................................................08

PROSTHESES
Hand, knee, lower leg and foot prostheses
More from page .........................................................12

We support our customers holistically and right from the start: From the first planning, support with certification questions, programming and production, up to quality management. And this customer-specific.

Horst Lindner
Head of the DMG MORI Medical Excellence Center
DECKEL MAHO Seebach GmbH

Dental
More than just dental crowns
More from page .........................................................18
INSTRUMENTS

Scissors, forceps, cloth clamps, guides, navigation
More from page ...........................................14

DEVICES

Focus on large devices
More from page ...........................................16

ADDITIVE MANUFACTURING
Two integrated process chains for powder bed machining
More from page ...........................................20

Integrated digitization
Planning, preparation, production, monitoring and service
More from page ...........................................22
Medical technology – a sector with innovation and growth potential

Demographic development and rising healthcare expenditure caused by a higher standard of living mean that medical technology experts are certifying extraordinarily high potential for growth.

MARKET DRIVERS OF THE MEDICAL INDUSTRY

Rising healthcare expenditure caused by:
+ 33% increase in the global population*
+ 266% increase in the number of people aged 65 and above*

*Comparing 2017 to 2050


PRODUCTION OF ORTHOPEDIC TECHNOLOGY WORLDWIDE

2017 vs. 2021

- Orthobiology: 21.9%
- Spine: 11.8%
- Trauma and CMF: 20.5%
- Extremities: 40.8%
- Hips: 11.1%
- Knees: 16.0%

DMG MORI MEDICAL EXCELLENCE CENTER

Development and consulting for and with our customers

+ Interdisciplinary experts advise our customers right from the start of potential projects with regard to topics like turning, milling, ULTRASONIC, automation and software
+ General transfer of expertise with other Technology Excellence Centers, e.g. with aerospace experts, for special requirements encountered in mill & turn applications involving large workpieces for tomographs, or with experts working in the additive manufacturing sector

GETTING OUR CUSTOMERS INVOLVED AT AN EARLY STAGE

DMG MORI MEDICAL EXCELLENCE CENTER

| Greenfield consulting | Process development | Consulting on regulatory issues | Turnkey/automation solutions | Machining new materials, e.g. developing machining strategies for SMAs (shape memory alloys) |
| Selecting the machines | Time study/technology | Quotation | Order | Delivery |

Your contact person

Horst Lindner
Head of the DMG MORI Medical Excellence Center

DECKEL MAHO Seebach GmbH
T +49 151 527 538 29
horst.lindner@dmgmori.com
### Overview

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### DMG MORI Medical Excellence Center

**DMG MORI Medical Consulting – Your entry into the medical business**

#### INTEGRATED TEAM APPROACH

**SUPPORT BY DMG MORI**

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<th>SUPPORT</th>
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<td>Supply Management</td>
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**Training**

- Support for ISO13485 company certification
- Support for introduction of QM system
- Training program for operation/management
- Documents for process description

**Operations**

- Support for customizing ERP system
- Technical specifications
- Manufacturing technology (machines, tools, periphery)
Strong regulations and comprehensive documentation due to the MDR (Medical Device regulations) are market barriers which DMG MORI Medical Consultancy tries to solve together with our customers. We support in every phase of Development, Testing, Documentation, Registration, Certification and Validation with our transparent and reliable future processes due to existing laws and Standards.

Marcus Krüger  
Key Account Manager for Medical Industries
DMG MORI MEDICAL EXCELLENCE CENTER

Your requirement – our solution

At our Medical Excellence Center in Seebach, we provide our customers with the experience gained from hundreds of successfully implemented medical projects. Together with our customers, we develop integrated technology solutions, define effective automation processes for the very best quality and autonomy and safeguard the processes with digitalized workflows. We are unique – as a complete provider of turning, milling, automation and software products, plus new technologies such as additive manufacturing, we offer solutions for all workpieces and requirements from a single source.

Overview

Four segments
Dental
Additive manufacturing
Integrated digitization

PRODUCTION FROM A BATCH SIZE OF 1 UP TO MASS PRODUCTION

- Flexible automation for a batch size of 1, e.g. for just-in-time production of custom-made patient implants → Production cell comprising one or more machines
- Automation for mass production, e.g. for standardized components such as screws → MULTISPRINT – SWISSTYPE

CUTTING – NEW MATERIALS

- Degradable Mg alloys → e.g. DMP 70 with fire extinguishing system and two-stage flame detector
- High-strength plastics, stainless steel and titanium → speedMASTER spindles up to 30,000 rpm or HSC spindles up to 60,000 rpm
- Hard-brittle materials (e.g. ceramics) and composites → ULTRASONIC machining
- SMAs (shape memory alloys) or polymers → Developing reliable machining strategies
DIGITAL AND AUTOMATED PROCESSES

+ Integrated process chain – from planning and CAD/CAM programming to production
  → CAD/CAM programming, e.g. NX CAM
  → Automatic transmission thanks to CELOS
+ Traceability of the entire production process from each individual workpiece
  → Automatic blank recognition via QR code
+ Increased process reliability
  → Camera-based component recognition

OPEN CONNECTIVITY

+ Connecting the machines to the customer’s MES (manufacturing executive system)
  → DMG MORI IoT connector as a bidirectional interface
  → Support e.g. for OPC UA, for sending and receiving data with a customized UDI interface
+ Continuous documentation of each workpiece
  → Barcode scanner – data is collected by means of the IoT connector directly at the customer’s MES system

QUALITY MANAGEMENT

+ Machine, technology and automation from a single source
  → Digital twin for green button process
+ 100% good parts or automatic ejection of faulty parts
  → Adaptive in-process measurement, e.g. CMM workpiece measurement or surface quality using CELOS APP Surface Analyzer
**DMG MORI MEDICAL – FOUR SEGMENTS**

**Implants – filigree components and screws**

<table>
<thead>
<tr>
<th>SHORT TURNING</th>
<th>LONG TURNING WITH SWISSTYPEkit</th>
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<tr>
<td><strong>Dental implant</strong></td>
<td><strong>Bone screw</strong></td>
</tr>
<tr>
<td>ø6 × 11 mm, titanium</td>
<td>ø4 × 20 mm, titanium</td>
</tr>
<tr>
<td><strong>Lamina hook</strong></td>
<td><strong>Monoaxial screw</strong></td>
</tr>
<tr>
<td>ø24 × 20 mm, titanium</td>
<td>ø16 × 70 mm, titanium</td>
</tr>
<tr>
<td><strong>Basic dental implant</strong></td>
<td><strong>Fixator screw</strong></td>
</tr>
<tr>
<td>ø7 × 12 mm, titanium</td>
<td>ø4 × 120 mm, titanium</td>
</tr>
</tbody>
</table>
SPRINT 20/SPRINT 32
+ Automatic lathes for workpieces up to ø 20 or ø 32 mm
+ SWISSTYPE kit for short and long turning on one machine:
  - SPRINT 20: extended spindle stroke from 60 to 180 mm
  - SPRINT 32: extended spindle stroke from 100 to 240 mm
+ <2.8 m² installation surface for the SPRINT 20,
  SPRINT 32 + 2.8 m² (without chip conveyor, ICS, etc.)
+ Automation via bar loader (optional)

MULTISPRINT 36
+ Multi-spindle automatic lathe for workpieces up to ø 36 mm
+ SWISSTYPE kit for short and long turning on a single machine: spindle stroke lengthened from 100 to 240 mm
+ Powered tools and Y-axis in all spindle positions
+ Automation via integrated bar loader or up to two integrated robots for chuck components up to ø 50 mm (optional)

THREAD WHIRLING FOR THE SPRINT AND MULTISPRINT
+ Patented unit for external thread whirling with direct drive
+ Machining up to a diameter of 15 mm, adjustable angle ± 15°
+ Cooled direct drive with 8 Nm torque and 2 kW power (10 % ED), speed range 1,500 to 4,000 min

SPRINT OR MULTISPRINT – ALWAYS THE RIGHT MACHINE FOR SERIES PRODUCTION
Example of a bone screw
+ 8 x 70 mm, titanium
+ Machining time:
  - SPRINT 20: 210 sec.
  - MULTISPRINT 36: 45 sec.
+ 30 % less space required for a MULTISPRINT 36 compared to 2 x SPRINT 20 (21.9 vs. 31.7 m² incl. bar loader, chip conveyor, etc.)
+ Use of the same cutting tool technology on SPRINT and MULTISPRINT
Implants – joints and bone plates

Overview

Four segments
- Implants
- Dental
- Additive manufacturing
- Integrated digitization

DMG MORI MEDICAL – FOUR SEGMENTS

NTX 1000

- Turn & Mill machining center for six-sided complete machining
- compactMASTER turning/milling spindle with 12,000 rpm (20,000 rpm optional) and 36-month warranty without any limit on the number of operating hours as standard
- Five-axis simultaneous machining thanks to DirectDrive B-axis with ±120° swivel range
- Four-axis machining thanks to second tool carrier as lower turret
- Automation via bar loader for workpieces up to ø65 mm or integrated and mobile robot (IMTR), for workpieces up to ø100 mm

DMG MORI technology cycle
Polyon/oval turning
- Simple machining of non-circular parts
- Intuitive user interface for polygon or oval turning
- Machining on main or counter spindle can be combined
Knee joint
ø 92 × 90 mm, CoCr
DMU 40 eVo: 42 min.

Bone plate
ø 12 × 20 × 118 mm, titanium
DMP 70: 35.5 min.

DMU 40 eVo
+ Five-axis universal machining center with up to 1 g acceleration
+ Swivel rotary table for machining of negative angles down to −20°
+ 20,000 rpm speedMASTER spindle with 36-month warranty without any limit on the number of operating hours as standard, optional HSC spindles up to 60,000 rpm
+ Automation as WH 8 or WH 15 Cell:
  WH 6 Cell: Workpieces up to 300 × 280 × 100 mm, 6 kg
  WH 8 Cell: Workpieces up to 300 × 300 × 130 mm, 8 kg
  WH 15 Cell: Workpieces up to 300 × 300 × 220 mm, 15 kg

DMP 70
+ Five-axis simultaneous machining through direct drive table up to 100 kg (optional)
+ 10,000 rpm inline spindle with 78 Nm as standard, optional 24,000 rpm to 12 Nm or 20 Nm (BT 30, SK 30)
+ 5 µm positioning accuracy thanks to direct measuring systems from MAGNESCALE
+ Up to 2 g acceleration for the shortest possible chip-to-chip time of 1.5 sec.
+ Automation as WH 3 Cell from the left, right or front: for workpieces up to 300 × 200 × 100 mm and 5.5 kg (3 kg as standard)

DMG MORI technology cycle
ATC 2.0 – application tuning cycle
+ Process-oriented adjustment of the feed speed in relation to table loading
+ Minimization of processing time with maximization of the relevant component quality

DMP 70 – MEDICAL PACKAGE
+ Stainless steel covers in the working area
+ Inline spindle with 24,000 rpm and 20 Nm
+ Swiveling rotary table for five-axis simultaneous processing incl. DMG MORI technology cycle 3D quickSET and ATC – application tuning cycle
+ toolSTAR tool magazine with 25 pockets
+ Chip conveyor and space saving 40-bar ICS
+ Tool measurement and measuring probe
+ Oil processing package incl. fire extinguishing system
Overview

**Four segments**

- Prostheses

**Dental**

Additive manufacturing

Integrated digitization

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**Prostheses – hand, knee, lower leg and foot prostheses**

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**Overview**

**Four segments**

- Prostheses

**Dental**

Additive manufacturing

Integrated digitization

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**DMG MORI technology cycle: 3D quickSET – turning**

- Measurement and correction of the position of rotary and swivel axes (C4/C3/B)
- Sag compensation possible
- Reliable recalibration of the machine prior to high-precision machining

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**Leg prosthesis component**

Ø 52 × 65 mm, aluminum NTX 2000: 8 min. 18 sec.

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**CTX beta 1250 TC 4A**

- Turn & Mill machining center for six-sided complete machining
- compactMASTER turn & mill spindle with 12,000 rpm (20,000 rpm optional) and 36-month warranty without any limit on the number of operating hours as standard
- **Five-axis simultaneous machining** thanks to DirectDrive B-axis with ± 120° swivel range
- Four-axis machining thanks to **second tool carrier as lower turret**
- Automation via bar loader for workpieces up to Ø 102 mm
DMU 50 3rd GENERATION

+ Five-axis universal machining center for workpieces up to ø630 x 500 mm and 300 kg
+ Swivel rotary table for machining of negative angles down to −20°
+ 15,000 rpm speedMASTER spindle with 36-month warranty without any limit on the number of operating hours as standard, optional speedMASTER spindles up to 20,000 rpm or 200 Nm
+ Automation as pallet handling PH 150
  - Max. load capacity 150 kg, 250 kg optional
  - Six pallets, each 320 x 320 mm, or ten pallets, each 400 x 400 mm

DMG MORI technology cycle
MPC 2.0 – machine protection control
+ In-process vibration monitoring
+ Rapid machine shutdown in the event of a crash
+ Manual retraction even on a tilted machining plane
+ NEW: Torque monitoring

ULTRASONIC INTEGRATION FOR RELIABLE MACHINING OF COMPOSITES

+ 40 % lower process forces and 100 % higher cutting speed due to ULTRASONIC overlay of the cutting direction
+ Ideal for trimming and drilling composite materials with clean edges without fiber tearing and delamination
+ ULTRASONIC integration in all five-axis machines from DMG MORI, e.g. DMU, DMU eVo, DMF, monoBLOCK, duoBLOCK, Portal and Gantry
Overview

Four segments
- Instruments

Dental
Additive manufacturing
Integrated digitization

DMG MORI MEDICAL – FOUR SEGMENTS

Instruments – scissors, forceps, cloth clamps, guides, navigation

Guide for traumatology
40 × 80 × 200 mm, titanium
DMP 70: 31 min.

DMG MORI technology cycle: 3D quickSET – milling
+ Tool kit for checking and correcting the kinematic accuracy of four and five-axis machine configurations
+ All head variants and table axes
Three machining philosophies – always the right solution

**Sequential machining**
- Optimum use of machinery with minimal requirements
  - Premachining incl. the connecting surfaces
  - The tips are reworked on five axes
  - Premachining: 7 min.
  - Five-axis machining: 3 min. 47 sec.

**Complete machining**
- Complete machining, incl. the tips on one machine
  - Five-axis complete machining: 9 min. 39 sec.

**Complete machining turn & mill**
- 60% lower costs for bar material
  - Six-sided complete machining, incl. machining of all freeform surfaces
  - Complete machining: 9 min. 31 sec.

---

**Forceps segment**
205 × 15 × 40 mm, X8CrNiS 18 – 9

**Bone rasp for femoral head prosthesis**
135 × 12.7 × 36 mm, X40CrMoV5-1
CTX beta 800 TC: approx. 145 min.

**DMG MORI technology cycle**
- Five-axis simultaneous machining
  - Free-form surfaces due to five-axis interpolation on the main and counter spindles
  - Turning and milling with interpolating B-axis
  - With ATC turning for increased machine dynamics
  - Look-ahead function for a continuous process

---

**CMX 600 V**
- Vertical machining center, with stable C-Frame design and high-precision IT1 ball screw drives
- Automation as a pallet pool:
  - 114-pocket pallet pool
  - PH 150 with up to ten pallet stations, each 320 × 320 mm
- Automation as WH 15 Cell workpiece handling: Workpieces up to 300 × 300 × 220 mm, 15 kg

**DMU 50 3rd Generation**
- Five-axis universal machining center for workpieces up to ø630 × 500 mm and 300 kg
- Automation as WH 8 or WH 15 Cell workpiece handling:
  - WH 8 Cell: Workpieces up to 300 × 300 × 130 mm, 8 kg
  - WH 15 Cell: Workpieces up to 300 × 300 × 220 mm, 15 kg

**CTX beta 800 TC**
- Turn & Mill machining center for six-sided complete machining
- Automation as workpiece handling:
  - Robo2Go workpieces from ø25 to ø170 mm
  - Bar loader for workpieces up to ø102 mm
Overview

Four segments
- Devices
- Dental
- Additive manufacturing
- Integrated digitization

DMG MORI MEDICAL – FOUR SEGMENTS

Devices – focus on large devices

1. Computer tomograph
2. Linear accelerator for tumor treatment
3. C-arm tomograph for use during surgery
DMC FD duoBLOCK AND PORTAL MACHINES

+ Ideal for bearings, housings and transmission rings for computer tomographs or formers for magnetic resonance systems
+ Milling/turning complete machining centers for workpieces up to:
  - DMC 125 FD duoBLOCK: ø1,250 mm
  - DMC 160 FD duoBLOCK: ø1,600 mm
  - DMC 210 FD: ø2,500 mm
  - DMC 270 FD: ø3,400 mm
  - DMC 340 FD: ø3,900 mm
+ Milling/turning table with DirectDrive technology
+ More than 20 years of experience with milling/turning machines, more than 1,000 installed machines [technology know-how from the aerospace sector, particularly casings and rotatives]

DMG MORI technology cycle: Grinding – milling

+ Milling, turning and grinding in a single setup
+ Best surface qualities up to Ra < 0.4 µm
+ Grinding cycles for interior, exterior and face grinding, plus truing cycles
+ Achievable tolerances
  - Surface quality < 0.4 µm
  - Circularity < 5 µm
  - Quality 9 with diameter < 120 mm
  - Quality 4 with diameter > 120 mm

CT Gantry (computer tomograph)
ø1,400 × 450 mm, titanium
DMG MORI MEDICAL – DENTAL

Dental – more than just dental crowns

HSC 20 linear / ULTRASONIC 20 linear

+ Precise production of implant-supported designs in all standard dental materials
+ Special DMG MORI dental blank holder for vibration-reduced production of titanium and CoCr alloys
+ Swivel ranges of the A-axis kinematics from –15° to +130° for complete machining of implant frameworks in a single setup
+ Production of inlays, onlays, veneers and crowns in lithium disilicate with ULTRASONIC technology → Minimization of chipping and micro-cracks, as well as thin preparation lines
+ Tool wear and tool breakage detection, incl. automatic program recoil and integration of sister tools
+ Fully automated production on <6 m² → HSC 20 linear or ULTRASONIC 20 linear with 99-fold pallet handling (max. 10 kg handling weight)

Additive manufacturing:
Dental crowns/bridges

<table>
<thead>
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<td>Glass ceramics</td>
</tr>
<tr>
<td>ZrO₂ (pressed)</td>
<td>ZrO₂ (cast)</td>
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Dental crowns/bridges

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Supra constructions

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Bars

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HSC / MILLING

+ Highly dynamic five-axis milling machining of high-end dental prostheses and implants with max. 60,000 rpm → e.g. white ZrO₂, PMMA, titanium and CrCo

ULTRASONIC

+ Overlay of tool rotation with an additional oscillating movement for economical hardmaching with diamond tools → e.g. glass ceramics and cast ZrO₂

Inlays, onlays

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Abutments

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Implants

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Special indications

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<tr>
<td>Metal-free palatal plates</td>
<td>ZrO₂ (cast) abutment posts</td>
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<tr>
<td>Promysan occlusal splints</td>
<td>ZrO₂ (cast) telescopes</td>
</tr>
<tr>
<td>CrCo, titanium abutment posts</td>
<td></td>
</tr>
<tr>
<td>ZrO₂, CrCo, titanium telescopes</td>
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Overview
Four segments
Dental
Additive manufacturing
Integrated digitization

DMG MORI – ADDITIVE MANUFACTURING

ADDITIVE MANUFACTURING

+ High-precision build-up of 3D components with layer thicknesses of 20 to 100 μm
+ Optimized gas flow control for the best component quality with minimal argon consumption
+ Maximum occupational safety due to closed material cycle and integrated powder preparation
+ Replaceable powder module rePLUG for contamination-free material changeover < 2h
+ CELOS: Integrated software solution from CAM programming with the RDesigner through to machine control

SELECTIVE LASER MELTING (SLM)

CELOS: Integrated software solution from CAM programming through to machine control
+ Intuitive machine operation thanks to touchscreen and app-based control
+ RDesigner – CAM programming directly at the machine:
  – Start with pure CAD model (STL)
  – Orientation/positioning
  – Support, slicing, hatching, copying
  – Generation of the process control file
+ HEAT calculation: Patented prediction of mass distribution and automatic adjustment of all laser parameters for the best component quality
+ Monitoring tools: Camera-based monitoring of the build-up and coating quality

CELOS

ADDITIVE MANUFACTURING IN THE POWDER BED
Component size max. 300 × 300 × 300 mm

CUTTING PROCESS

24
NEW: Optomet – innovative and integrated software solution

+ Automatic calculation of process parameters for new and existing materials in a matter of minutes
+ 20% lower material costs – improved usability of already recycled powder without loss of quality
+ Pre-calculation of mechanical properties for selected materials thanks to integrated material database
+ Adjustment of the process parameters to:
  - Changed layer thicknesses, changed requirements (density, tensile strengths, etc.)
  - New powder suppliers/powder properties (e.g., recycling powder)
+ Optional: rePLUG reSEARCH – the powder module specifically developed for material development with OPTOMET

THE DIRECT ROUTE TO THE FINISHED PART!

Sample application:
Basic tibial plateau
+ Material: Ti6Al4V
+ Machining time for milling: 12 min/unit
+ Processing time for additive manufacturing: 9 hours (nine parts)
+ Layer thickness: 50 µm
+ Dimensions: 75 x 57 x 53 mm

Cutting process

Additive manufacturing in the powder bed
Component size max. 300 x 300 x 300 mm

Dental – Perfect-fit dental indications, such as bars, crowns or bridges made of cobalt chrome or titanium.

Medical – Individually adapted and tailor-made titanium implants. Complex lattice structures, e.g., in hip and knee implants.
DMG MORI – DIGITAL SOLUTIONS

Integrated Digitization

ISTOS PLANNING SOLUTIONS
+ Integrated production planning and control system
+ Managing the complexity of all systems and processes
+ Connection to all machines and workstations

PLANNING, FEEDBACK AND COCKPIT
+ Dynamic planning of production orders
+ Direct confirmation of the production status
+ Machine and process data in real time

PREPARATION
CAD/CAM SYSTEMS
+ SIEMENS NX CAM and ESPRIT CAM
+ Continuous processing of design data
+ Reduction in order throughput times by up to 50%

SIMULATION
+ DMG MORI Virtual Machine and VERICUT
+ 100% reliable NC program provision
+ Shorten machine run-in times by up to 90%

PRODUCTION
CELOS MACHINE
+ More than 14,500 CELOS machines in the field
+ CELOS with SIEMENS, MAPPS AND HEIDENHAIN

CELOS PC VERSION
+ Create and manage orders
+ Transfer data directly from the PC to the machine
+ Optimize machine utilization and process flow
**MONITORING AND SERVICE**

**NETservice and SERVICEcamera**
* Reduce machine downtimes remotely
* Quick error localization and optimum support

**IoTconnector and RETROFIT KIT**
* Simple retrofitting to DMG MORI machines
* Basis for future applications

**MESSENGER AND PRODUCTION COCKPIT**
* Current status of all DMG MORI machines
* Digital analysis of the production process

**SERVICE AND MAINTENANCE**

**DOCUMENTATION AND CERTIFICATION**
* 100% consistent documentation
* Perfectly prepared for audits

**MAINTENANCE AND REPAIR**
* Up to 50% faster machining
* Automatic maintenance reminders

**COMMUNICATION**
* Fast transmission of information
* Digital “blackboard”
DMG MORI MEDICAL EXCELLENCE CENTER

Your contacts

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